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SETTING WATER QUALITY CRITERIA IN CALIFORNIA

by Vinton W. Bacon, M. ASCE, and
Charles A. Sweet, A.M. ASCE

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SETTING WATER QUALITY CRITERIA IN CALIFORNIA

Vinton W. Bacon,[1] M. ASCE and Charles A. Sweet,[1] A. M. ASCE

SYNOPSIS

Under legislation enacted in 1949, the program of water pollution control in California has two distinct goals: to protect the quality of the waters of the state for present and future beneficial uses and, simultaneously, to permit planned usage of these waters for waste disposal. The 4-step process whereby water quality criteria are set and waste discharges are controlled is explained and illustrated. The relationship of criteria established by the pollution control boards and the important California Water Plan (which, when enacted by the Legislature, may include criteria for certain beneficial uses of water) is also explained.

INTRODUCTION

The "Preliminary Statement of Objective and Policy,"[2] adopted by the State Water Pollution Control Board at its first official meeting in January, 1950, laid down certain basic principles to serve as a guide in controlling water pollution within the framework and philosophy expressed in the California laws. The principles are stated in these words:

> "The objective of the State Water Pollution Control Board is the prevention and control of pollution and contamination of the waters of the State at a minimum of expense consistent with obtaining this objective. In achieving this objective, it will be the policy of this board that its actions and those of the regional water pollution control boards shall be so directed as to secure that degree of care in the planning and operation of works for the treatment and disposal of sewage and industrial wastes as will adequately protect the public health and all of the beneficial uses of waters in this State and at the same time permit the legitimate planned usage of those waters for receiving suitably prepared wastes so that an orderly growth and expansion of cities and industries may be possible."

It is readily apparent that this policy statement provides for two distinct and somewhat conflicting goals to be achieved simultaneously. The first aims for protection of the quality of the waters of the state for present and future beneficial uses (domestic, industrial, agricultural, navigational, recreational, or other use). The second aims for the maximum use of these waters for waste disposal.

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1. Respectively, Executive Officer and Assistant to the Executive Officer, California State Water Pollution Control Board, Sacramento, Calif.
2. "Preliminary Statement of Objective and Policy, and Report on Water Quality Evaluation," California Water Pollution Control Board Publication No. 4 (1952).

The purpose of this paper is to explain the process whereby water quality criteria are set to achieve these goals and to show how the proposed California Water Plan, when enacted by the Legislature, relates to this process.

Administrative Organization

In discussing methods and means of establishing water quality criteria to protect specified water uses, it is first necessary to describe briefly the California water pollution control program and to explain the basic concepts behind this program.[3] When the Legislature revised the water pollution control laws in 1949, it created a decentralized state organization by dividing the State into nine regions. The regional boundaries are based on major watershed areas and are shown in Figure 1.

Within each region, there is appointed by the Governor a five-man regional water pollution control board. As shown in Figure 2, each board member must be selected from a specified field. It is intended that representation from these five fields will provide an equitable balance in water pollution control activities—activities that must consider both economical waste disposal and preservation of the beneficial uses of water.

A 14-man State Water Pollution Control Board was also created by the 1949 legislation. As shown in Figure 2, nine board members are appointed by the Governor from seven designated fields. The remaining five members are state officials representing the agencies listed. And, as in the case of the regional boards, representation on the state board is designed to provide a balance of the interests of the water user with those of the waste discharger. A total of 12 major fields of interest are represented on the State Board.

In their control work, the regional boards are autonomous and have been assigned the primary responsibility for controlling water pollution within their respective regions. As regulatory agencies, they have three principal duties: (1) formulating and adopting long-range plans and policies, (2) setting and enforcing waste discharge regulations, and (3) coordinating the interests of other agencies. The State Board, serving in a coordinating and appellate capacity, is directed to: (1) formulate a state-wide policy for control of water pollution with due regard to the authority of the regional boards, (2) review acts of a regional board where the regional board has failed to take or obtain appropriate action to correct a condition of pollution, (3) administer state-wide programs of research or of financial assistance for water pollution control, and (4) allocate funds for the administrative expenses of the regional boards.

Although the foregoing remarks show some of the differences in structure and duties of the state and regional boards, both types of board must go through the same process in setting water quality criteria. Therefore, for the chief purpose of this discussion, no differentiation will be made between the boards. In most instances they will be referred to as "control boards" or merely "boards."

Steps in Controlling Pollution

A control board follows four simple steps in controlling pollution. They are:

3. A more detailed discussion of the program is contained in "Progress Report for 1950 Through 1952," California Water Pollution Control Board Publication No. 5 (1952).

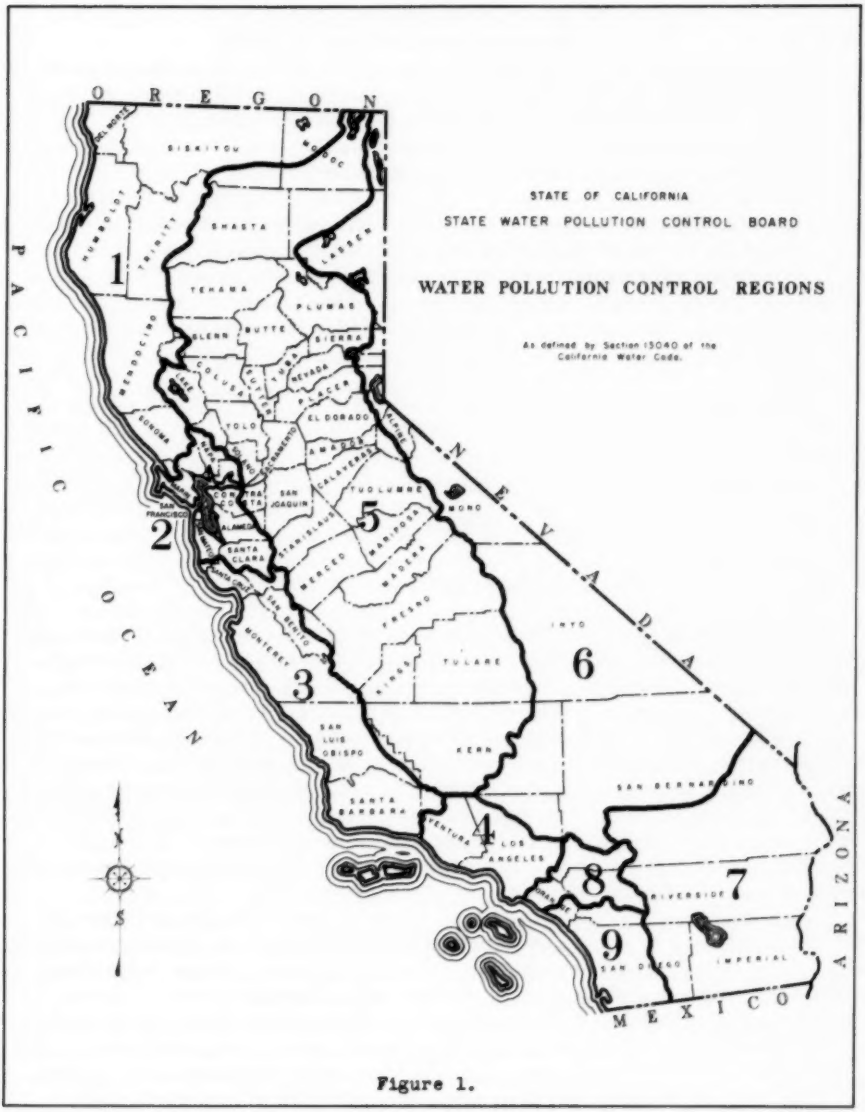


Figure 1.

1. Enunciates beneficial water uses which it intends to protect.
2. Defines water quality criteria to protect beneficial water uses.
3. Prescribes waste discharge requirements.
4. Checks compliance and enforces requirements.

These four steps are interrelated, and all are important functions of the boards, but only the first two will be stressed in this paper.

FIELDS REPRESENTED ON WATER POLLUTION CONTROL BOARDS	
REGIONAL BOARD (5 members)	STATE BOARD (14 members)
Water supply Irrigated agriculture County government City government Industrial waste	Water supply Irrigated agriculture County government City government Industrial waste Industrial water use Public sewage disposal Dept. Agriculture Dept. Fish and Game Dept. Natural Resources Dept. Public Health Div. Water Resources

Figure 2.

Enunciation of Beneficial Water Uses

In considering the first step, it is necessary to explain what is meant by beneficial water uses and why their enunciation becomes so significant in this program. "Pollution" is defined in the California statutes as an impairment of the quality of water by sewage or industrial waste to a degree which adversely and unreasonably affects waters for domestic, industrial, agricultural, navigational, recreational, or other beneficial use. There is no pollution if beneficial uses of water are not adversely and unreasonably affected. Thus, it is evident that the first problem facing the control board, either in the development of long-range plans and policies or in the prescribing of requirements to regulate individual waste discharges, is that of determining the beneficial water uses to be protected.

The control board does not establish water uses. The Water Pollution Control Act clearly states: "No provision of this division shall be construed as affecting the right of any person to the use of water for any beneficial use other than the use for disposal of sewage and industrial wastes." Water uses are determined by factors such as the State Water Plan, authorized water projects, established and planned future water uses, water rights, the economy of the area, land uses, and local and regional planning programs.

The control board enunciates water uses which it intends to protect. Prior to making this declaration, the board considers established water uses, planned future uses, and need for economical waste disposal. The board also recognizes that the total interest in any water pollution control program encompasses both economical waste disposal and preservation of the beneficial uses of water. To be certain that all interested parties are heard, the board invites comments on each case, holds informal meetings and discussions, conducts a formal public hearing where necessary, and, lastly, after weighing all the facts, acts upon the matter at a public meeting. In this way, the board serves as arbiter with the duty to hear all interested parties, to evaluate all factors, and, then, to enunciate water uses which it intends to protect.

Setting of Water Quality Criteria

After the control board enunciates water uses which it intends to protect, it must establish limits on physical, chemical, and bacteriological characteristics (or concentrations) beyond which the quality of the waters are impaired for beneficial uses. The process of defining these limits (or "water quality criteria" as they are often called) can be illustrated by a simple, hypothetical case.

Assume that a community, which is situated on the banks of an inland river, desires to dispose of its sewage and industrial wastes in the river. After considering all factors and interests, the control board determines that it will preserve the river for irrigation, bathing, and fishing. The community will have to provide waste treatment to the extent that the river downstream from the outfall will meet water quality criteria suitable for these uses.

In determining water quality criteria, the control board customarily consults with agencies and individuals who are experts in particular fields of water use. This consultation, although not mandatory, is the normal procedure. However, it should be emphasized that the final decision in all cases rests with the water pollution control board. In the hypothetical case, irrigation water authorities (such as universities, agriculture experiment stations, the Agricultural Extension Service, the Division of Water Resources, the Department of Agriculture, etc.) would be asked what would be a maximum concentration of dissolved minerals beyond which the river water would be considered impaired for irrigation of crops. Say that the authorities recommend a maximum of 700 parts per million (ppm) of dissolved minerals in this case, and that the control board adopts this value as one of its criteria. This figure should have a reasonable margin of safety in it, and therefore, should not be considered the point below which the board is unconcerned with the waste discharge or above which the board must rush into enforcement proceedings. When the dissolved minerals concentration is considerably less than 700 ppm, conditions in the river should be satisfactory. Should the concentration of dissolved minerals approach the 700 ppm criterion, particularly over a prolonged period, the possibility of unreasonable impairment (i.e., pollution) would be recognized by the control board, and the waste discharge would be subject to immediate study and careful checking to determine whether enforcement proceedings should be initiated against the discharger.

To complete the hypothetical case, criteria for irrigation water use are also determined for characteristics such as sodium ratio and boron concentration. Using the same procedures, additional criteria are determined (after consultation with public health, fish and game, and other authorities) for protection of the bathing and fishing uses of the river water. Again, a reasonable margin of safety would be embodied in these criteria to assure protection to the public health and the fisheries resources as well as the agricultural interests.

Figure 3 shows the defined water quality criteria for each of the beneficial uses of water in the hypothetical case. As long as the limits shown in the second column are not exceeded, the quality of water is not unreasonably impaired for the uses indicated and there is no pollution. Regulations (or requirements, as they are called in the Water Pollution Control Act) controlling individual waste discharges would be prescribed so that conditions in the receiving water would be maintained within these limits. Should the limits be exceeded, the water uses would be considered in jeopardy. Since a

Figure 3.

DEFINITION OF WATER QUALITY CRITERIA

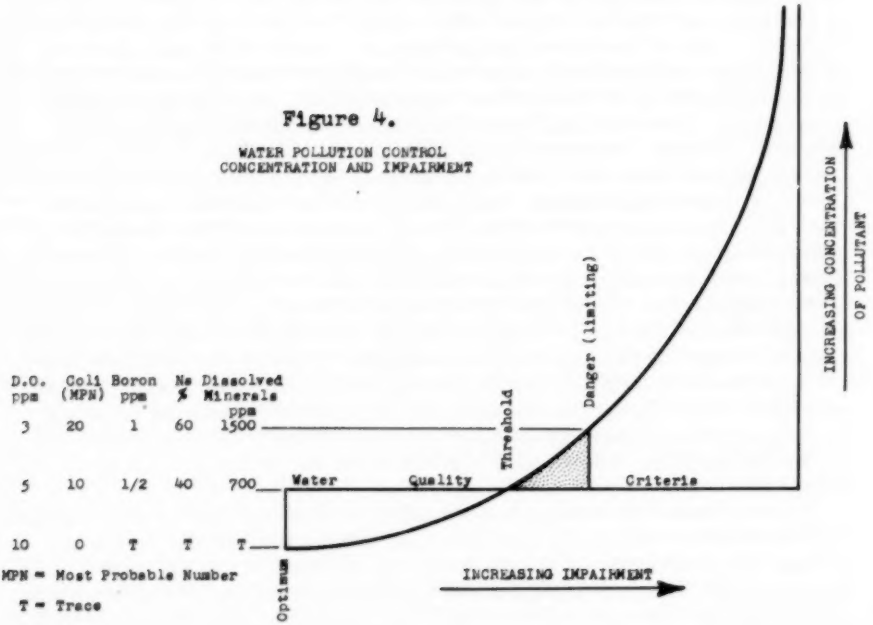
Beneficial Use to Be Preserved in River Water	Water Quality Criteria Prescribed by Control Board to Prevent Pollution		Possible Conditions If Pollution Not Controlled
Irrigation	700 ppm* dissolved minerals, maximum 40% sodium ratio, maximum 1/2 ppm boron, maximum		High concentrations; crop damage and loss of production
Bathing	10 coliform bacteria per milliliter, maximum		High coliform counts; an actual hazard to public health (contamination)
Fishing	5 ppm of dissolved oxygen (D.O.), minimum		Low dissolved oxygen; reduced fisheries resources or fish kills

*Parts per million

SATISFACTORY	CAUTION	DANGER
AREA OF NOT UNREASONABLE IMPAIRMENT		AREA OF UNREASONABLE IMPAIRMENT

Figure 4.

WATER POLLUTION CONTROL
CONCENTRATION AND IMPAIRMENT



reasonable margin of safety has been incorporated in the criteria, a "caution" area exists between "satisfactory" and "danger" conditions. If concentrations are not controlled and pollution occurs, actual damage of the type listed in the last column will result.

Figure 4 shows graphically (but only roughly to scale) the criteria values and the concepts expressed in Figure 3. The curve, rising from left to right, depicts increasing concentration of material which can pollute the receiving water. The horizontal line represents the criteria set by the control board. Every beneficial use of water imposes two values to each of its water quality criteria: first, a value (threshold) at which the use is not significantly impaired by the concentration, and, second, a value (limiting) at which the beneficial use is, to all practical purposes, inhibited or destroyed. These two values are plotted on the graph. When concentrations are below the horizontal line (i.e., less than threshold values), the water is satisfactory for the indicated beneficial uses. Between the threshold and limiting values, quality of the water is questionable. This is the caution or "yellow light" zone. At concentrations above the limiting value, actual damage can occur.

It should be recognized that the hypothetical case has been over-simplified. In an actual case, criteria in addition to those shown would very likely be given, especially to protect irrigation and fishing. Additional or different water uses would have to be considered. Seasonal variations in water use would dictate seasonal variation in water quality criteria. If during certain seasons the waters are not used for bathing, or if the fish can tolerate a lower dissolved oxygen concentration, the discharger could reduce his waste treatment costs by making greater use of the waste assimilative capacity of the river. There are many other variables which must be considered in actual cases to keep waste disposal costs at a minimum while affording adequate protection of the receiving waters.

In the hypothetical case, criteria were set for one particular point in a surface stream. The relationship of these criteria to other reaches of the same river and to individual waste discharge requirements is discussed in the next three paragraphs.

Different criteria would very likely be set for different reaches of the river. In every area of varied topography and diverse land and water uses, there develops sooner or later a general pattern of water quality zones. In primitive catchment areas of little or no habitation and industry, streams remain largely in their natural state and quality of water is generally excellent. In the flat valley and plains areas, streams receive return drainage from irrigation and, at scattered locations, wastes from the sewerage systems of towns and industries. The quality of water in streams in such areas has moderate concentrations of mineral and organic matter, but is still satisfactory for most uses. Lastly, there are areas near the mouths of streams or near bays and harbors where wastes from cities and industries are concentrated, and these waters are usually unfit for those uses requiring a high degree of purity. In Figure 4 this difference in criteria for different reaches of the same river would be shown by varying the position of the horizontal line (the water quality criteria line).

The California water pollution control program does not sanction planned classification or zoning of surface or underground waters according to major uses (or abuses) of such waters. (This is the so-called classification system in which waters are grouped as Class A, Class B, Class C, etc., and thereafter these waters are pegged, for all practical purposes, to that degree of

usefulness.)[4] It is true that the pattern of water-use development described in the preceding paragraph and the criteria developed by the control boards to protect water uses, may eventually result in a form of classification or water quality zoning. But, in this case, the land and water use growth pattern will control the classification of water quality—rather than a preconceived, and possibly arbitrary, classification system controlling the growth. Even if at some future date the pattern of development and the water quality criteria set by the control boards results in a form of classification, the individual waste discharge requirements would continue to be prescribed on a case-by-case basis so that waste treatment would be no more costly or elaborate than necessary to protect the receiving waters.

Regulations for control of individual waste discharges are subject to revision from time to time. This does not mean that the discharger is constantly faced with upgrading of requirements on an arbitrary basis. It does mean that his right to the use of waste assimilative capacity in a disposal area or receiving water is subject to proration among other communities and industries which develop after all of the assimilative capacity is used. When a control board sets water quality criteria to protect present and future uses of a body of water, it is literally defining waste assimilative capacity. Any difference between the defined criteria and the existing concentrations of organic and inorganic matter represents additional waste receiving capacity. This additional capacity is available to the waste discharger, but, when it is all utilized, the regulations on all individual discharges are subject to revocation and revision so that an orderly growth of cities and industries may continue. In revising the discharge requirements, the waste receiving capacity is prorated equitably among the dischargers. Although there have been only a few instances where such proration was involved, nevertheless, practically every regulation prescribed by a control board warns the discharger that the requirements are subject to change in order to permit future orderly growth without jeopardizing water quality.

Prescribing Waste Discharge Requirements and Enforcement

As mentioned earlier, this paper is concerned primarily with the first two steps followed by the boards in controlling pollution. However, brief mention will be made of the remaining two steps, both of which pertain to waste discharge requirements.

The prescribing of discharge regulations is a statutory responsibility—and almost a daily duty—of the regional boards. (The State Board may prescribe requirements, but only in the event that a regional board failed to take or obtain appropriate action to control pollution.) As pictured in Figure 5, a prospective discharger of sewage or industrial waste is required to file only one report consisting of a simple, single-page form. The board forwards copies of the form and any other pertinent data to all interested and affected parties, thus starting the process of coordination. Where facts are lacking, the board asks state or local agencies to make special technical investigations. Before formulating tentative discharge requirements, the board invites comments and recommendations from interested agencies, and informal or formal hearings may be held to develop additional facts. All parties are notified when the

4. The subject of stream classification is further discussed in "An Analysis of Water Quality Criteria," by J. E. McKee and Vinton W. Bacon, Proceedings, ASCE, Volume 79, Separate No. 231.

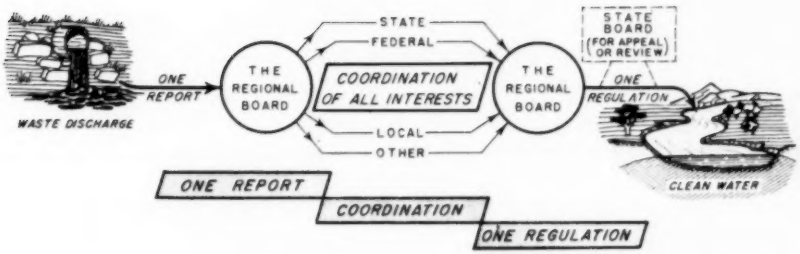


Figure 5.

board meets to prescribe final discharge requirements. This, the third step, is completed with the waste discharger receiving a single set of regulations.

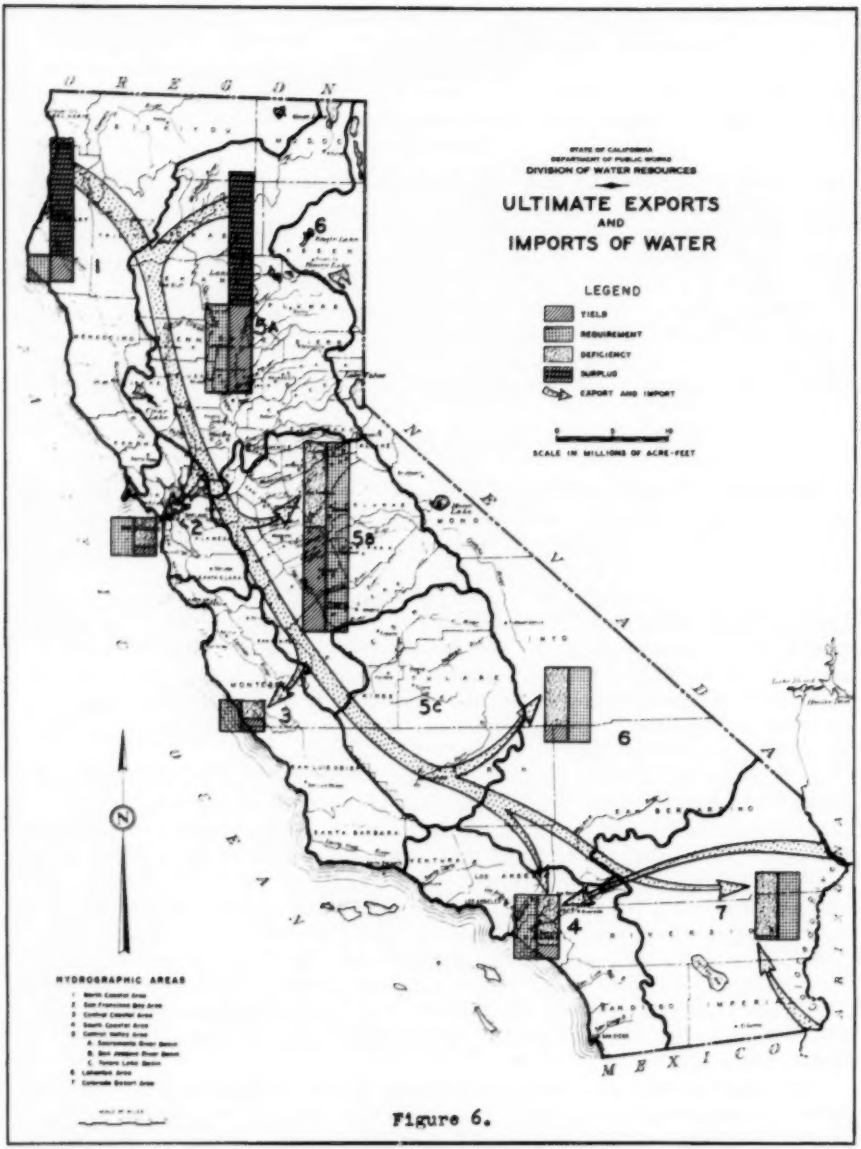
In the fourth (and last) step, the control board maintains a check on the prescribed requirements to see that they are complied with. If it appears to the board that a waste discharger is violating the requirements, the discharger is first given an opportunity to present his case in administrative hearings. Should the board then decide that a pollution exists or is threatened, correction is ordered. If the waste discharger refuses to comply with the board's orders, the case is turned over to the district attorney for prosecution.

Relationship of Criteria to California Water Plan

The process which the boards follow in controlling pollution has been outlined and described under four basic steps. However, one phase of the process described in this paper may have to be modified in light of the proposed California Water Plan. In discussing the second step of the process, it was pointed out that, although the control boards consult with authorities in the field of water quality, the discretionary power and responsibility for establishing water quality criteria rests solely with the water pollution control boards. There will be a major exception to the last statement if the Water Plan, when enacted by the California Legislature, specifies water quality criteria for exported, or other, waters. To understand the reason for this exception, a brief explanation of the Plan is necessary.

California has a critical water problem resulting from the fact that the northern one-third of the State is an area of surplus waters whereas the central and southern portions of the State are essentially areas of water deficiency. Three-fourths of the State's water crop falls north of a line drawn through the City of Sacramento, yet three-fourths of the need for water is south of that line. It's simply a matter of poor distribution on the part of nature and is shown vividly in Figure 6. The solution to the ever-growing problem of water shortages in the southern two-thirds of the State is being evolved in a California Water Plan which will propose exporting water from areas of surplus to areas of deficiency. The widely-publicized Feather River Project, shown in part in Figure 7, is one important feature of the State Water Plan.

The Plan is being developed by the State Water Resources Board pursuant to broad authorizations of the Legislature. The Board, through the Division of Water Resources, is now engaged in conducting state-wide surveys and studies of water resources and ultimate water requirements. These studies encompass both water quantity and water quality. Upon completion of the proposed water plan, the Water Resources Board will recommend it to the Legislature. If the plan includes recommendations on water quality, and if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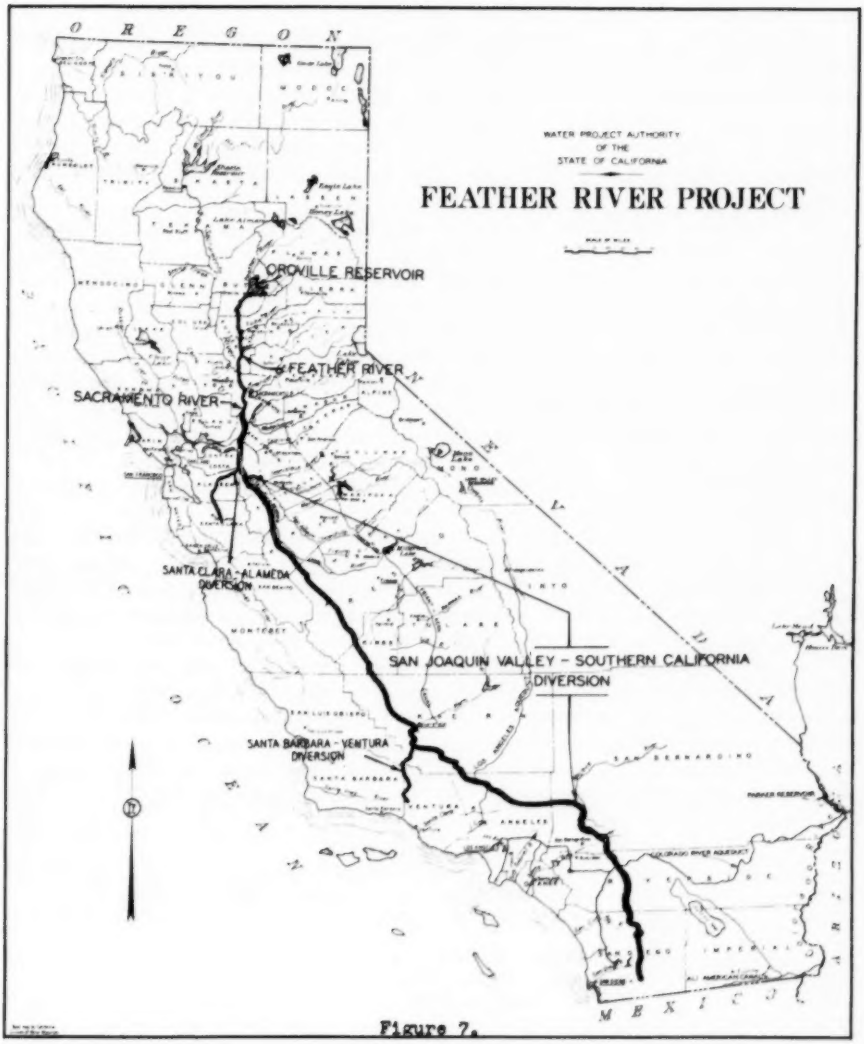
IMPORTS OF WATER
LEGEND
YIELD
REQUIREMENT
DEFICIENCY
SURPLUS
EXPORT AND IMPORT
SCALE IN MILLIONS OF ACRE-FEET
HYDROGRAPHIC AREAS
1
2
3
4
5A
5B
5C
6
7

Figure 6.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DIVERSION
SANTA BARBARA - VENTURA
DIVERSION
MEXICO

Figure 7.

the Legislature in adopting a California Water Plan fixes quality requirements for waters of the State, then these requirements become mandatory. The setting of water quality criteria would no longer be a discretionary responsibility of the water pollution control boards.

SUMMARY

This paper has discussed the California approach to the control of water pollution, with particular emphasis on the setting of water quality criteria designed to protect beneficial water uses. Basic principles to this approach are set forth in a statement of objective and policy. Briefly, these principles provide for preservation of present and future beneficial water uses while at the same time permitting maximum usage of the waters for economical waste disposal.

Nine regional boards have primary responsibility for the control of water pollution in California. The State Board has ultimate authority in that it may review the actions of a regional board. As regulatory agencies, the regional boards formulate and adopt long-range plans and policies, prescribe and enforce waste discharge regulations, and coordinate the interests of other agencies. The State Board formulates state-wide policy, reviews the action of a regional board if necessary, administers research programs, and allocates funds to the regional boards.

These boards follow four basic steps in controlling pollution: (1) enunciation of beneficial water uses, (2) definition of water quality criteria, (3) prescribing waste discharge requirements, and (4) checking and enforcing requirements.

In enunciating water uses to be protected, the boards serve as arbiter with the duty to hear all interested parties and to evaluate all factors. Water uses are not established by the control boards but are determined by factors such as the California Water Plan, authorized water projects, established and planned future water uses, water rights, economy of the area, etc.

To insure protection of defined water uses, the boards must establish water quality criteria. Although this is usually done by consulting with authorities in particular fields of water use, the final decision rests with the control boards with one exception. This exception would be in the event that the Legislature, in adopting the proposed California Water Plan, would specify water quality requirements for certain waters in the State.

PROCEEDINGS-SEPARATES

The technical papers published in the past year are presented below. Technical-division sponsorship is indicated by an abbreviation at the end of each Separate Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways (WW) divisions. For titles and order coupons, refer to the appropriate issue of "Civil Engineering" or write for a cumulative price list.

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MAY: 435(SM), 436(CP)[c], 437(HY)[c], 438(HY), 439(HY), 440(ST), 441(ST), 442(SA), 443(SA).

JUNE: 444(SM)[e], 445(SM)[e], 446(ST)[e], 447(ST)[e], 448(ST)[e], 449(ST)[e], 450(ST)[e], 451(ST)[e], 452(SA)[e], 453(SA)[e], 454(SA)[e], 455(SA)[e], 456(SM)[e].

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c. Discussion of several papers, grouped by Divisions.

e. Presented at the Atlantic City (N.J.) Convention in June, 1954.

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